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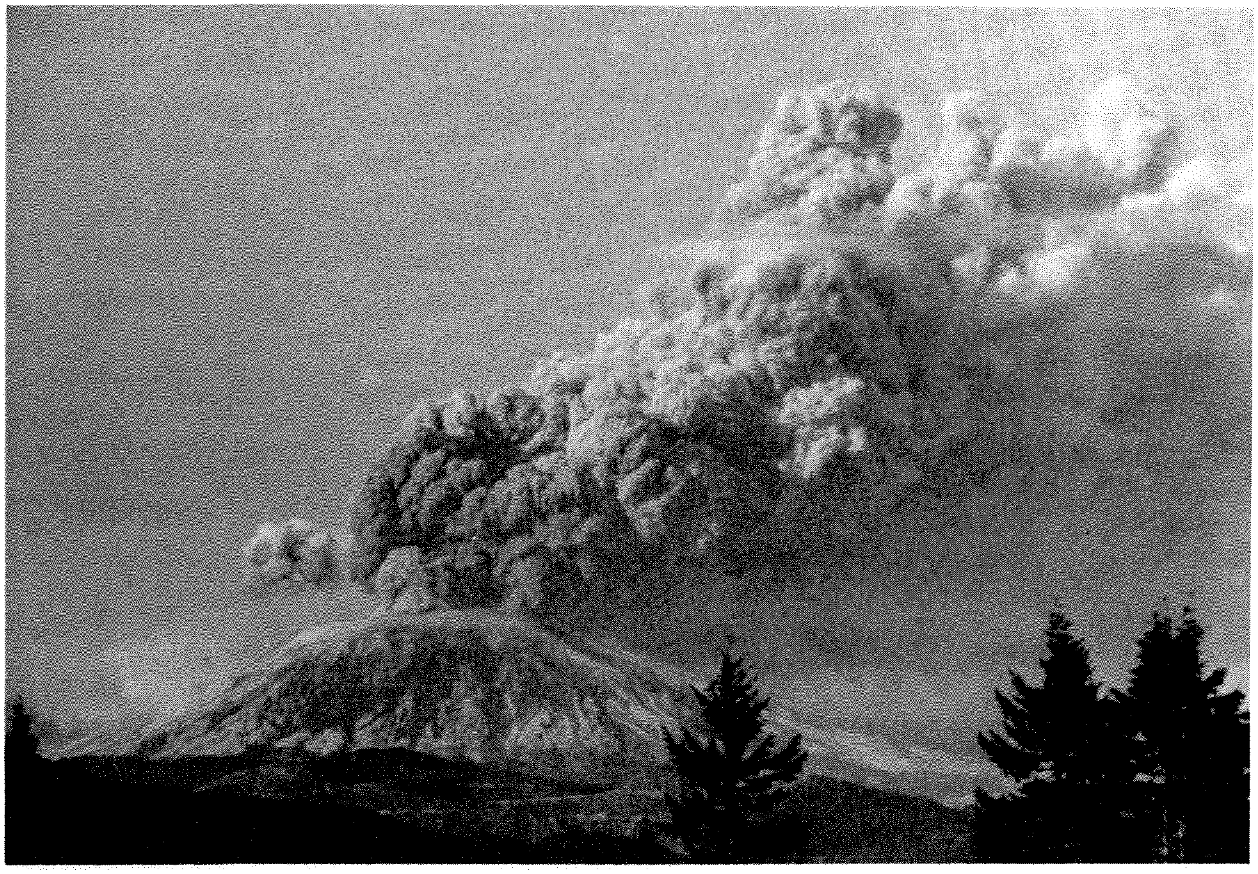

May 18, 1980, eruption of Mount St. Helens. View from south in late afternoon.

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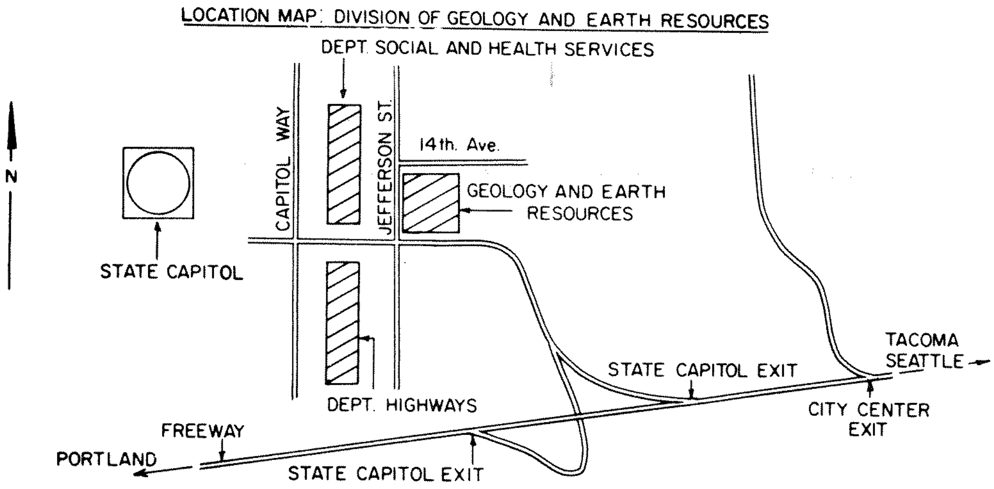

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The division also publishes bulletins, information circulars, and geologic maps. A list of these publications will be sent upon request.

SEQUENCE OF VOLCANIC ACTIVITY OF MOUNT ST. HELENS, MARCH 20 - JUNE 23, 1980[1/]

By James G. Rigby and Michael A. Korosec,
Division Geologists

The following summary of events leading to the major eruption of Mount St. Helens on May 18, 1980, has been compiled from U.S. Geological Survey and University of Washington daily updates of volcanic and seismic activity, and from notes and daily reports collected by Jim Rigby of the Division of Geology and Earth Resources while assisting the U.S. Geological Survey in Vancouver. In most cases, only the most important activity of the day is reported, ignoring minor activity which is usually emphasized on slower days. In addition, weekend reports are not as detailed as those of weekday events. This does not, of course, reflect the actual activity of the volcano. Some of the earthquake magnitudes (stated as Richter magnitudes) are preliminary.

March 20 - March 26 — A minor earthquake of 4.1 Richter magnitude was recorded in the vicinity of Mount St. Helens on the afternoon of March 20. This was the first sign that an eruptive phase had begun. Over the following week, swarms of microearthquakes were recorded, reaching magnitudes of up to 4.4 and triggering minor avalanching. The number and intensity grew, reaching a peak on March 26, although intensities were somewhat higher on March 25 than on the 26th.

March 27 — A thick black plume of ash and steam was exploded from the volcano's summit at 12:36 p.m., rising to a level about 7,000 feet above the newly opened crater, which measured about 250 feet in diameter. Extensive long cracks were visible in the ice crossing the crater on the north and south, and running down the west and east sides of the volcano. One hundred and thirty-five earthquakes were recorded greater than magnitude 3, ranging up to 4.7.

March 28 — Steam eruptions continued through the day, commonly to elevations of 14,000 to 16,000 feet. Small avalanches and mudflows moved down the upper flanks of the cone. One hundred and thirty earthquakes, greater than magnitude 3 were measured, ranging from 3.2 to 4.9.

March 29 — A second crater was observed on the northeast side of the old crater which had apparently opened during the night before. The new opening measured about 75 feet wide and 30 to 60 feet deep. Eruptions observed during the day would begin as combinations of ash and steam, but would convert to steam only by the end of the eruption. One hundred and thirty-eight earthquakes greater than magnitude 3 were recorded, ranging up to 4.4. The "blue flame" was first observed during the night of the 29th, coming from the smaller, northeastern crater.

March 30 — Minor eruptions continued at a rate of about one every ½ to 1½ hours. The largest ash eruptions to date were noted,

[1/] March 20 - May 17 from Division of Geology and Earth Resources Information Circular 71.

and the crater was slowly being enlarged. Seventy-nine earthquakes in the range of magnitude 3.2 to 4.6 were recorded. The blue flame was seen during the night again.

March 31 — Explosive eruptions continued, and the two craters merged, with a low saddle between them. Seventy-five earthquakes were recorded, along with the first harmonic tremor reported.

April 1 — Ash and steam eruptions reached elevations of 16,000 feet. Several small fumarole vents only a few feet in diameter opened up around the east crater on the northeast side. Avalanching and mudflows were observed, especially along the north flanks, and a thermal infrared survey detected a hot spot at about an elevation of 5,000 feet just west of the Timberline area. Seventy-six earthquakes over magnitude 3 were recorded, and a weak, brief harmonic tremor occurred.

April 2 — Many small steam eruptions were intermingled with occasional larger steam and ash eruptions, reaching elevations of 14,000 to 15,000 feet, and one large eruption in the late afternoon to about 20,000 feet. Eighty-eight earthquakes over magnitude 3 were recorded. The blue flame was last seen on this date, and another harmonic tremor occurred.

April 3 — Ash and steam eruptions were accompanied by several earthquakes greater than magnitude 4, with the largest measuring 4.9. In addition, harmonic tremors were recorded again, as during the last 2 days.

April 4 - April 14 — Earthquake activity continued at a moderate rate, with 2 to 5 events per day in the range of magnitude 4.0 to 4.7. A small eruption occurred on the 8th of April, but eruptive events were generally lacking during this period, and seismic activity decreased towards the end of the period. Harmonic tremors occurred on the 4th, 5th, 7th, 10th, and 12th.

April 15 - April 22 — There was very little change in the frequency of eruptive activity, with a few small steam eruptions occurring daily. There was a slight decrease in seismic activity during the beginning of this period, but the level picked up on the 20th, with 57 earthquakes over magnitude 3, and with 7 earthquakes greater than magnitude 4. No harmonic tremors were recorded during this period.

April 23 - May 6 — Over this period, there was virtually no eruptive activity. Steaming, while sometimes intense at the beginning of the period, was reduced to smaller fumarolic activity by the end of April. The formation of a bulge on the north-northeast flank was detected on April 23, and was suspected to have been growing since the eruptions in March. By the end of April, the area was defined as being 1 mile long and 0.6 mile wide. The axis of the elongated area trended northeasterly from the north side of the summit crater toward the Sugar Bowl. The maximum uplift had been 320 feet, and Goat Rocks was moving north-northwest at about 5 feet a day. The area affected included the Forsyth, Leschi, and Loowit Glaciers. By May 1, it was determined that the bulge was moving out laterally faster than it was being uplifted. Seismic activity continued at a slightly reduced rate, with further decrease on April 30, but returned to former levels (about 31 per day over magnitude 3) during the first week in May, with 5 to 8 events greater than magnitude 4 daily. No harmonic tremors were recorded.

May 7 - May 14 — Eruptive activity increased dramatically with steam and ash eruptions reaching elevations of 13,000 feet with increased sulfur emission. Steam emissions were also detected at two sites on the Boot on the north flank, and from crevasses at the head of Shoestring Glacier on the southeast flank. The feature at Shoestring was enlarged somewhat by the end of the period. The lateral bulging continued on the north-northeast flank, slowing down on May 10 and 11, but picking back up by the end of the period to about 5 feet per day. Large magnitude seismic activity increased during this period, with 6 to 11 events greater than magnitude 4 daily, although the number of earthquakes between magnitudes 3 and 4 decreased slightly. Two harmonic tremors occurred on May 8.

May 15 - May 17 — Eruptive activity decreased, with only very few minor short-term steam eruptions. The bulge continued to grow at about the same rate, and seismic activity over magnitude 3 decreased from 39 per day on May 15, to 33 on the 16th, to 18 on the 17th, with 8 earthquakes over magnitude 4 on the 15th, 10 on the 16th, and 6 on the 17th. No new or magmatic-derived materials were found in the ash erupted from the onset of volcanic activity in late March to the present.

May 18 — Mount St. Helens erupted cataclysmically at 8:32 a.m. on May 18, sending billowing columns of ash high into the atmosphere. The eruption was preceded seconds earlier by a Richter magnitude 4.9 earthquake, which triggered landsliding of a large portion of the north flank of the mountain along a fairly flat, steep plane. A cloud of dark ash rose from the north flank, vertically at first, then quickly spread laterally to the north. Immediately afterward, an explosive lateral blast was directed northward through the still-moving slide block, closely followed by a summit eruption of ash and steam. The summit eruption plume soon rose to approximately 50,000 feet in altitude, drifting eastward across the Cascades. Ash flows, pyroclastic flows, and mudflows soon followed and continued for most of the day causing extensive flooding along the Toutle River and other drainages. An increase in activity at about 4:30 p.m. pushed the ash column to approximately 63,000 feet in altitude. A harmonic tremor began at 11:43 a.m. and lasted for 300 minutes.

May 19 — The ash eruption of the 18th continued well into the 19th, but at a greatly diminished rate, with the plume rising to heights of only 1,000 to 2,000 feet above the summit. Observations of the volcano revealed the entire north flank gone; the greatly enlarged and deepened crater was now horseshoe shaped, open to the north, with the south of the mountain being the highest part of the volcano at approximately 8,000 feet in height. The lip of the open crater on the north was estimated to be at about 4,500 feet in elevation. The area for several miles to the north of the crater appeared totally devastated, with all trees blown down and removed by the blast within approximately 5 miles of the north side of Mount St. Helens. This zone was surrounded by another belt of destruction about 5 to 6 miles in width in which most trees were blown down but were still lying on the ground, many smouldering. Beyond this, the trees were still standing, but their needles appeared dead and brown. This zone was estimated to be up to 2 miles wide. Seismic activity continued but at a greatly reduced rate; from midnight on the 18th to midnight on the 19th, only 3 earthquakes over magnitude 3 occurred, and the depths of seismic activity increased from less than 8 miles before the major eruption to 15 or more miles. Several small fumaroles were noted in the debris flow west of Spirit Lake, and one strong fumarole was emitting ash near the west end of Spirit Lake, along with several other small fumaroles.

May 20 — Eruptive activity continued, but was further diminished, having turned from ash to steam emissions during the evening and night of the 19th. Seismic activity continued to decline, with no earthquakes over magnitude 3 (the last one over 3 was at 7:22 a.m. on the 19th). A temperature measurement 2 feet down into a pyroclastic flow near the volcano yielded a temperature of 147°C. Steam and ash were still being vented from the fumaroles in the debris flow west of Spirit Lake. The U.S. Geological Survey (USGS) confirmed that the ash emitted during the eruption of the 18th was juvenile.

May 21 — Eruptive and seismic activity continued at about the same level; observations were limited due to poor visibility. The USGS placed markers around the shore of Spirit Lake to help monitor changes in the lake level. It was determined that the chance of the lake spilling over and flooding the Toutle River again was less likely than previously thought a day or two ago. Four earthquakes over magnitude 3 occurred. A tiltmeter on the south side of the mountain showed no significant changes.

May 22 — Steam continued to be emitted from several vents in the crater floor of the volcano. A hydrogen sulfide (H_2S) odor was detectable in the steam plume, which rose to 1,000 to 2,000 feet above the summit, and visibility remained generally poor throughout the day. There was only one earthquake over magnitude 3, and seismicity was still occurring at deeper levels (6 to 12 miles) than those prior to the eruption of the 18th. Some landslides on the southeast crater wall fell into the crater producing some seismic activity. An earthquake was reported at Mount Margaret.

May 23 - 24 — Conditions remained about the same during this period with steam being emitted from the numerous vents in the crater floor, which lies about 3,000 feet below the south rim. In addition, the crater was estimated to be approximately 1 to 1.5 miles in width (E-W), and 2 miles in length (N-S). Seismic activity continued at a low level with only one earthquake over magnitude 3 (a magnitude 4.0 at 3:46 p.m. on the 24th).

May 25 — Renewed activity began early in the day. Harmonic tremors began at 2:36 a.m. and were quickly followed by a swarm of earthquakes. This seismic activity originated approximately 5 miles under the cone and generally involved quakes with magnitudes less than 2. A moderate sized ash eruption began a few minutes later and eventually grew to an altitude of about 45,000 feet. By 9:00 a.m., the earthquake swarm and harmonic tremors had ended. The ash eruption continued throughout most of the day at a subdued rate, depositing ash from northwest to southwest of the volcano for considerable distances. Poor visibility hampered around-the-clock observations, but the eruption apparently ended before 1:00 a.m. on the 26th.

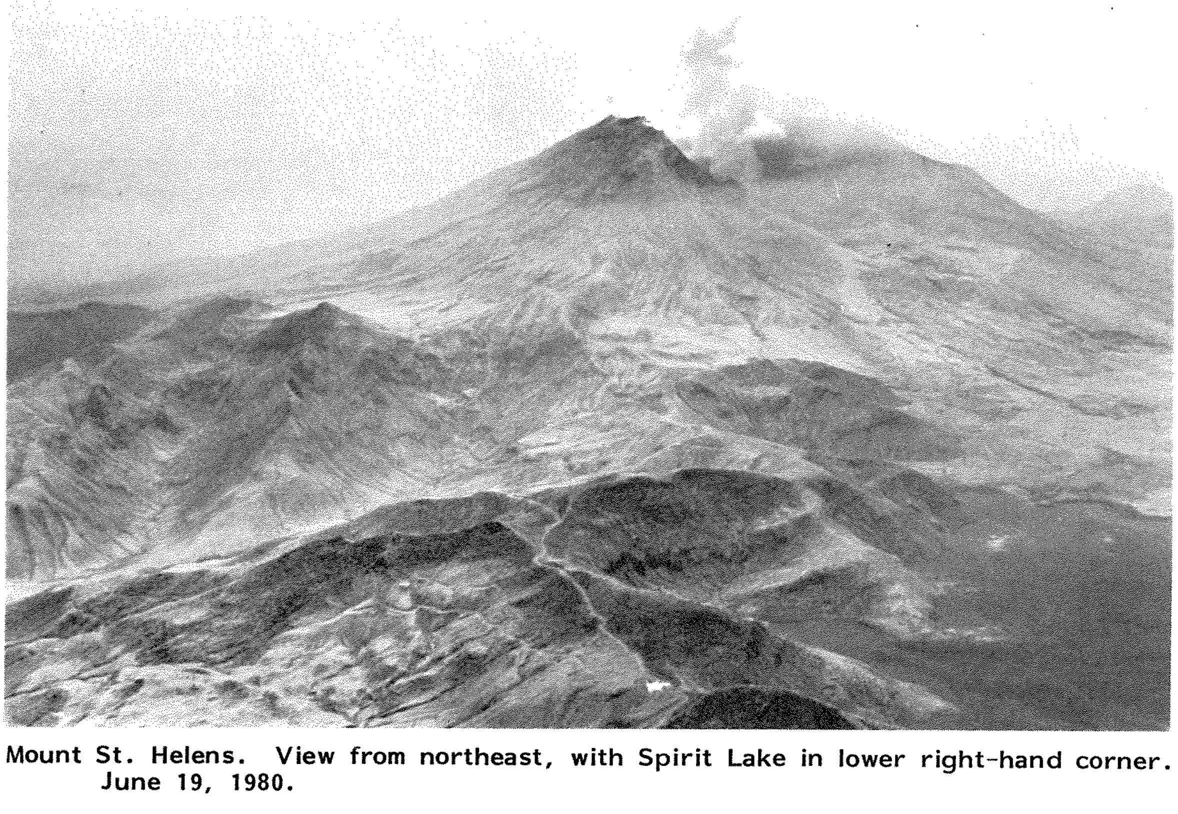
May 26 - 31 — Eruptive and seismic activity continued to decline during this period with only mild emissions of steam occasionally mixed with small amounts of ash. The odor of H_2S gas could frequently be detected near the volcano. Only 2 earthquakes greater than magnitude 3 occurred during this period (both on the 28th and near Mount Margaret). Reports of sightings of glowing magma on the crater floor were later reported erroneous—areas were seen at night that were warm enough to glow, but this apparently was due to surface rocks being heated from below.

June 1 - 11 — Mount St. Helens remained in a very low-level state during this period. The crater vents continued to produce steam emissions, which generally rose between 10,000 to 12,000 feet in altitude. Occasionally, small amounts of ash were present in the eruptive column. Earthquakes were either few in number or entirely absent and were of small magnitude. A continuous, small amplitude harmonic tremor, however, appeared in the seismic record for most of the first week of June. Also, minor ground tilting (approximately 1 microradion per day) to the southwest of the area south of the volcano was reported continuing and to be relatively unchanged since several days before the eruption of May 18. Rock avalanches into the crater occurred at times during this period. On June 9, improved visibility permitted the discovery of a previously unknown lake in the northern part of the crater floor. Calculations showed that Mount St. Helens has been emitting about 150 to 250 metric tons of SO_2 per day, or more than 10 to 30 times the amount it erupted before May 18.

June 12 — A weak harmonic tremor began in the afternoon, with a marked increase in amplitude at 7:05 p.m. An eruption of steam and ash was reported coming from the crater at 7:10 p.m., rising to a height of 13,000 feet. Radar observations placed the column to 37,000 feet a short time later. Eruptive activity continued at about the same rate until another marked increase in the ongoing harmonic tremor occurred at 9:11 p.m. The ash column rose to 50,000 feet. Heavy ash emissions and strong harmonic tremors continued until a little past midnight when activity began to slow. A light ash fall occurred in areas southwest of the volcano.

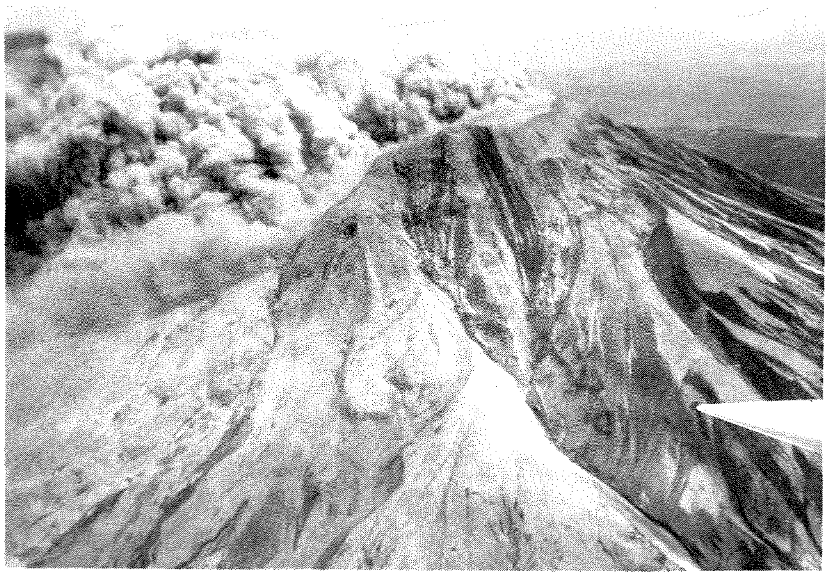
June 13 — The eruption and harmonic tremors continued at a reduced rate. Poor visibility limited observations of the volcano.

June 14 - 23 — Seismic and eruptive activity returned to a low level once again. A persistent plume of steam and minor ash continued to be emitted, generally rising to altitudes of less than 15,000 feet. No significant earthquakes and no harmonic tremors were recorded. Of significance, however, was the detection on June 15 of the formation of a small lava dome on the floor of the crater. When discovered, the dome measured about 600 feet in diameter and was less than 120 feet in height. By June 23, it had grown to be 660 feet long and 200 feet high. The tiltmeters around the volcano have recorded a reduced rate of swelling of the mountain during this period



Mount St. Helens. View from northeast, with Spirit Lake in lower right-hand corner. June 19, 1980.

Phreatic eruption crater of Mount St. Helens. April 11, 1980.



View of Mount St. Helens from the northwest. May 19, 1980.

House damaged by mudflow of May 18, 1980. Toutle River area.

PETROLOGY OF CURRENT MOUNT ST. HELENS TEPHRA

By Glennda McLucas, Division Geologist

The recent tephra eruptions of Mount St. Helens, which covered much of eastern and southwestern Washington and spread easterly across the United States, consist of composite ash falls composed chiefly of volcanic glass and plagioclase feldspar with minor hypersthene, clinopyroxene, magnetite, and quartz. This article briefly describes some physical and chemical properties of ash samples from widely spaced localities in Washington.

Tephra eruptions in the geologic past from Mount St. Helens have varied widely in composition, often within the same eruptive period, from dacite through andesite and basalt. Since March 27, 1980, Mount St. Helens has undergone four tephra eruptions, representing dacitic to andesitic source material. The initial eruption of March 27, distributed in the immediate vicinity of the vent, represented an expulsion of crystal-rich, glass-deficient old dacitic vent material. This tephra is composed predominantly of plagioclase crystals (An_{30-50}) with minor hypersthene, clinopyroxene, and magnetite; minor amounts of tridymite were detected by X-ray diffraction. Table 1 presents a chemical analysis of this tephra (Shulters and Clifton, 1980).

The major eruption of May 18 resulted in composite ash falls that were distributed eastward from the vent. The varying composition of the ash falls was due, perhaps, to the following factors: (1) changing composition of the tephra during the course of the eruption, from old vent and summit material to juvenile magma, with tephra of different composition encountering different wind patterns; (2) shifting winds during the eruption; (3) layering of windborne ash at different altitudes; and (4) distance from the volcano. Variations in tephra color

TABLE 1.—Semiquantitative analyses of volcanic ash from Mount St. Helens, March 27 eruption (Shulters and Clifton, 1980)

Elements	Percentage of sample, by weight
Iron (Fe)	3
Magnesium (Mg)	1
Calcium (Ca)	3
Titanium (Ti)	.3
Silicon (Si)	>10
Aluminum (Al)	7
Sodium (Na)	2
Potassium (K)	1
Phosphorus (P)	.04
Sulfur (S)	.08
	Parts per million (ppm) of sample, by weight
Manganese (Mn)	700
Arsenic (As)	2
Gold (Au)	<.2
Boron (B)	10
Barium (Ba)	300
Beryllium (Be)	2
Cadmium (Cd)	.2
Cobalt (Co)	20
Chromium (Cr)	7
Copper (Cu)	30
Lanthanum (La)	20
Nickel (Ni)	10
Lead (Pb)	10
Scandium (Sc)	15
Strontium (Sr)	500
Vanadium (V)	70
Yttrium (Y)	15
Zinc (Zn)	100
Zirconium (Zr)	150
Gallium (Ga)	30
Ytterbium (Yb)	2
Praseodymium (Pr)	<20
Neodymium (Nd)	<20
Samarium (Sm)	<50
Europium (Eu)	<1

from medium gray to near white are due to the presence or absence of heavy dark ferromagnesian minerals (magnetite, hypersthene, and clinopyroxene).

Observers in Pullman noted a dramatic change in the ash fall in the late afternoon. From 2:00 p.m., when ash fall began in Pullman, until 5:15 p.m., when the change occurred, the tephra was dark and composed predominantly of plagioclase crystals (An_{50}), colorless to dark-brown microlith-rich glass, and composite lithic fragments of plagioclase and glass. The tephra contained 5 to 10 percent by volume titaniferous magnetite, 1 percent by volume basaltic hornblende, and occasional crystals of orthopyroxene. The dark tephra may represent siliceous andesitic cone material dispersed in the first explosion or may simply be due to preferential gravitational settling of heavy minerals (predominantly magnetite and hypersthene). A comparison of major oxides from the St. Helens summit material (pyroxene andesite) by Verhoogan (1937) and (dark ash) Hooper and others (1980) is shown in columns A and B of table 2. Between 5:15 and 5:30 p.m. the ash fall changed abruptly to a pale ash with a volume two to four times that of the previous dark ash. It is composed of 80 percent microlith-poor vesicular glass, and 15 to 20 percent plagioclase with minor iron-oxide and hornblende, as well as minor quartz and biotite recorded by electron microprobe. Table 2 columns A and C represent a chemical analysis of the Pullman tephra (Hooper and others, 1980).

TABLE 2.—Weight percentage of major oxides in Mount St. Helens ash

	A	B	C	D	E	F
SiO_2	64.21	63.16	68.20	64.54	61.90	63.46
Al_2O_3	17.20	18.22	16.15	18.69	19.43	16.62
TiO_2	0.70	.54	0.53	.60	.73	.63
Fe_2O_3	2.21	1.36	1.66	5.46	6.84	5.57
FeO	2.53	3.33	1.90	---	---	---
MnO	0.07	Tr.	0.05	.08	.11	.08
CaO	5.07	5.24	3.70	5.56	6.05	5.39
MgO	1.85	2.30	1.22	2.62	3.63	2.40
K_2O	1.52	1.16	1.85	1.29	1.06	1.43
Na_2O	4.47	4.06	4.57	4.49	4.36	4.41
P_2O_5	0.19	.14	0.15	---	---	---

A = average of 3 analyses of dark ash, May 18, 1980 eruption, Pullman tephra, Hooper and others, X-ray fluorescence analysis.

B = pyroxene andesite, summit of Mount St. Helens, Verhoogen, 1937.

C = average of 4 analyses of pale ash, May 18, 1980 eruption, Pullman tephra, analyses by Hooper and others, X-ray fluorescence.

D = Mount St. Helens sheet, April 8, 1980 eruption, atomic absorption analysis by G. Mustoe.

E = Yakima tephra, May 18, 1980 eruption, atomic absorption, analysis by G. Mustoe.

F = Randle tephra, May 18, 1980 eruption, atomic absorption, analysis by G. Mustoe.

TABLE 3.—*Petrographic analyses of Mount St. Helens tephra (W. S. Moen, 1980)*

(Percent by Volume)

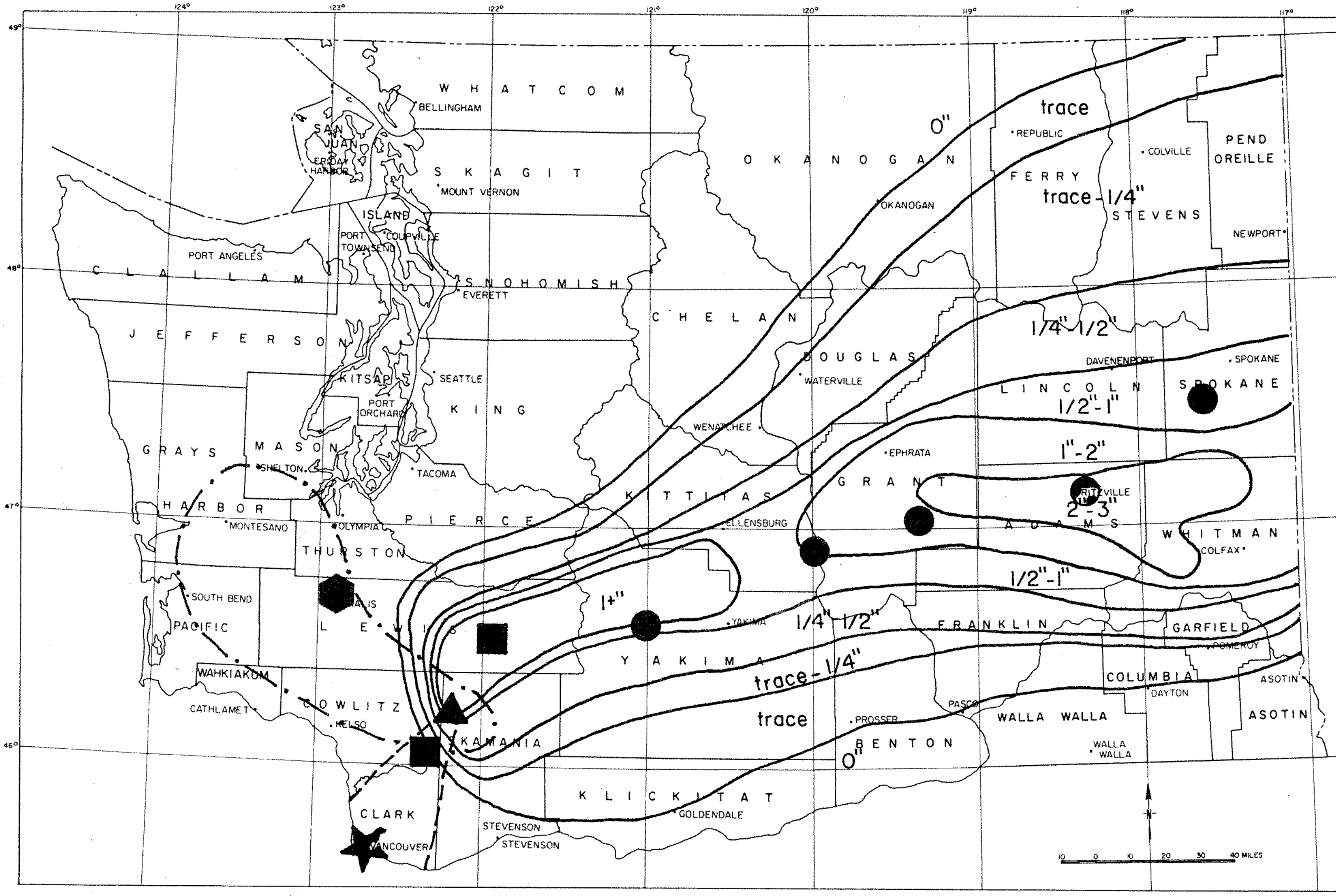
Locality	Glass	Plagioclase	Hypersthene	Clinopyroxene	Magnetite	Quartz
			March 27			
Randle	10	85 An_{30-50}	4	0.5	0.5	<1
Cougar	10	75 An_{30}	6	2	2	5
			May 18			
Ahtanum	50	49 An_{30-50}	0.5	0.5	<0.5	<1
Vantage	10	75 An_{30-50}	10	---	5	<1
Moses Lake	60	39 An_{50}	0.5	0.5	<0.25	<1
Ritzville	80	19 An_{50}	0.5	0.5	<0.5	<1
Cheney	70	28 An_{35-50}	0.5	0.5	<0.5	<1
			May 25			
Centralia	47	51 An_{50-58}	1.0	0.5	<0.5	<1
			June 12			
Vancouver	44	54 An_{55}	1.5	<0.5	<1.0	<1

Division analysis of May 18 tephra began with selection of five sample locations on a transect between Mount St. Helens and Spokane, along the axis of the major ash fall plume (see fig. 1). While changes in the glass-plagioclase ratio occur along this transect, the changes are random and cannot be correlated with distance of transport from the vent. See table 3 for petrographic analyses.

The Vantage sample (collected 5 miles west of Vantage) represents an anomalous situation in that it is unusually low in glass (less than 5 percent), high in plagioclase (An_{30-50}, 80 percent), hypersthene (10 percent), and magnetite (5 percent), and free of clinopyroxene. Seventy-seven percent by weight of the Vantage tephra is nonmagnetic material composed of plagioclase and hypersthene, 12 percent by weight is strongly magnetic material consisting chiefly of titaniferous magnetite, and 11 percent by weight is weakly magnetic material consisting of plagioclase and hypersthene with dust-like magnetite as inclusions. Because of the marked compositional and color difference between the Vantage tephra and other tephra samples along the transect, it can be inferred that the Vantage material represents a separate ash plume or the winnowing action of turbulent air currents.

Overall the division's petrographic evaluation of the tephra corresponds to that in table 2 (Hooper and others) in that it represents a dacitic-andesitic magma[1/] composed of vesicular glass shards ranging from 50 to 80 percent by volume, plagioclase crystals (An_{30-50}, trending toward labradorite), ranging from 20 to 75 percent, 0.5 percent each of hypersthene, clinopyroxene, amphibole, and magnetite. Quartz was detected only in one sample. Spectrographic

1/ Based on mineral composition of ash rather than norm calculations from chemical analyses.



EXPLANATION

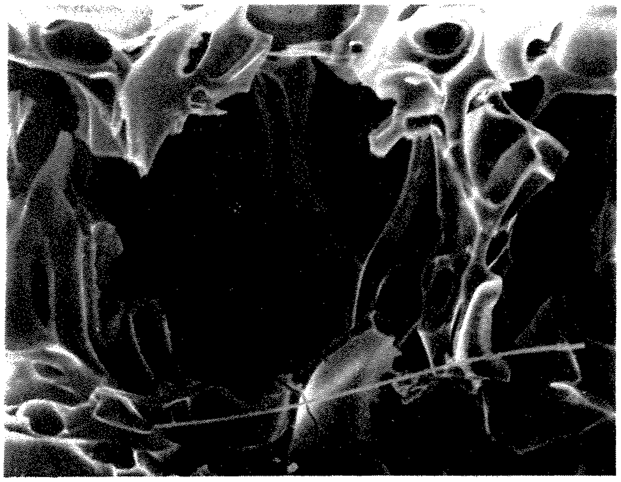
Ash fall distribution contours:

- ———— May 18 eruption
- —·—·— May 25 eruption
- - - - - June 12 eruption

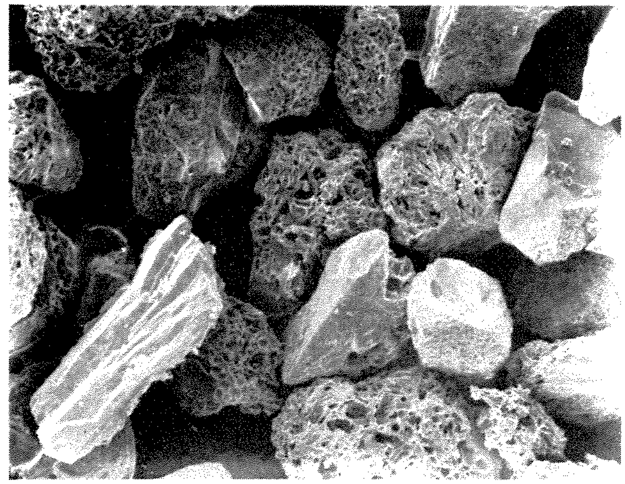
Sample localities:

- ■ March 27 eruption
- ● May 18 eruption
- ⬢ May 25 eruption
- ★ June 12 eruption

FIGURE 1.—Sample locality map (Ash thickness distribution base after J. G. Rigby, 1980).



A. Vesicular glass fragment, X 1000.



B. Tephra particles, X 100. Light-colored plagioclase crystal at lower left is ½ mm in length.

Scanning electron photomicrographs of Mount St. Helens tephra. (Photos courtesty of Dave Pevear, Western Washington University.)

analysis of the five samples showed very small differences in the percentages of constituent elements.

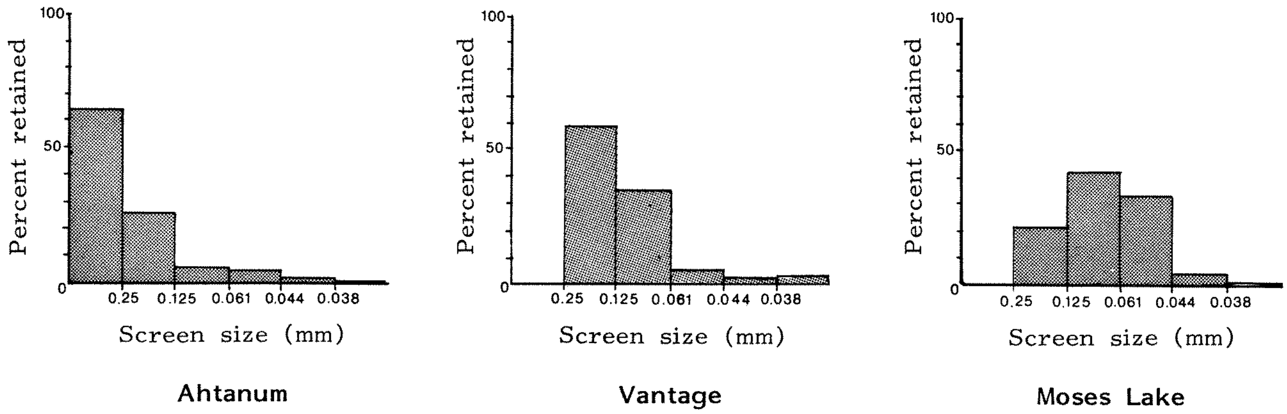
Figure 2 demonstrates grain size distribution along the transect from Mount St. Helens to the Idaho-Montana border (Lookout Pass). Grain size diminishes rapidly from the vent to Moses Lake (160 miles northeasterly), maintains a plateau across the Columbia Basin from Moses Lake to Cheney (250 miles), then drops off again to the Idaho-Montana border (350 miles). Color for dry tephra remains the same across the transect (10 YR 7/1, light gray), except for the Vantage tephra (10 YR 5/1, gray) which is much darker.

Table 4 demonstrates the decrease in crystal size eastward from Vantage to Cheney.

TABLE 4.—Crystal-size distribution (in microns)

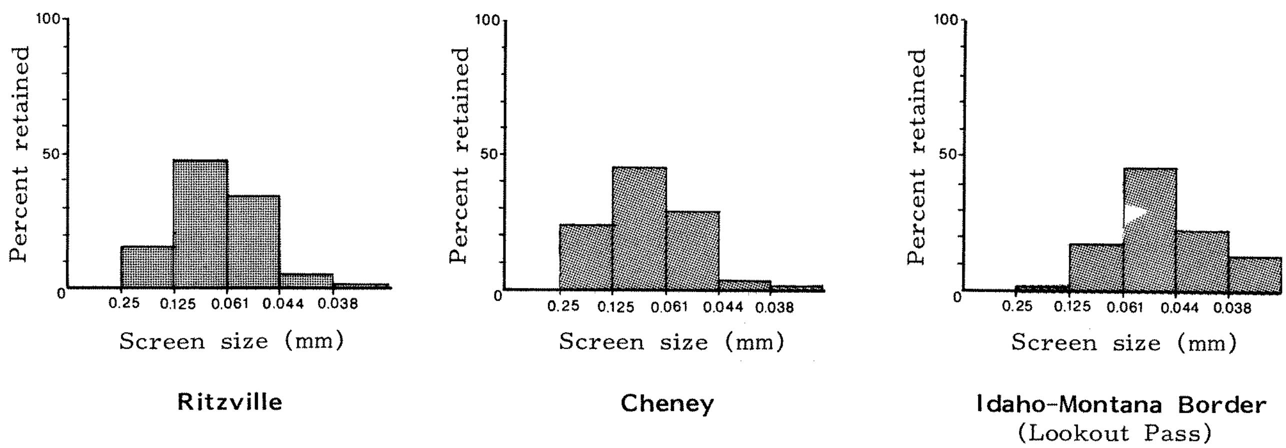
Mineral	Vantage	Cheney
Plagioclase	315	144
Glass shards	276	132
Hypersthene	375	150
Magnetite	180	120

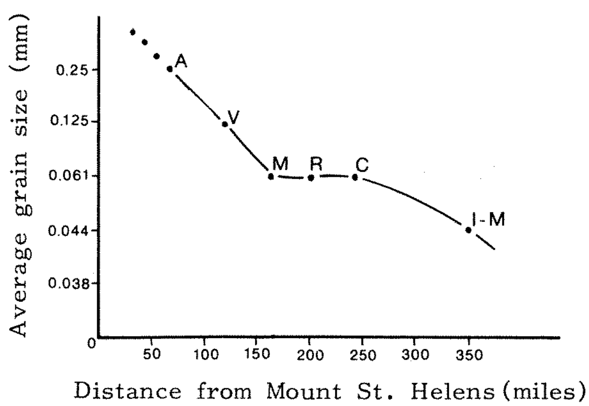
Volcanic glass from the 1980 St. Helens tephra has a refractive index of n=1.502 to 1.505. The glass occurs as colorless to brown splintery shards and contains microlitic inclusions (±1 micron) of hypersthene, glass and plagioclase, and crystallitic (dust-like) inclusions of magnetite, in addition to vesicles (±12 microns). Occasionally hypersthene and feldspar crystals are partially or completely enclosed in vesicular glass jackets with broken vesicles, implying that magmatic crystallization was in progress before the explosive event. Those crystals without jackets are often abraded and pocked with micro-impact or thermal shock structures. This condition, in addition to the roundness of the hypersthene and pyroxene crystals and the extreme angularity of the plagioclase crystals, suggests that a considerable amount of solidification, vesiculation, and fragmentation took place before the tephra fragments were explosively vented to the atmosphere. Most of the vesicular glass was probably broken into fragments after cooling of the glass and much break-



Grain-size scale for sediments

0.25 to 0.125 mm	= fine sand	0.061 to 0.038 mm	= coarse silt
0.125 to 0.061 mm	= very fine sand	0.038 to fines	= medium silt to clay





A = Ahtanum (66 miles)
V = Vantage (120 miles)
M = Moses Lake (158 miles)
R = Ritzville (202 miles)
C = Cheney (244 miles)
IM = Idaho-Montana Border
(Lookout Pass, 350 miles)

FIGURE 2.—Grain-size distribution for May 18, 1980 eruption.

age was caused by attrition during explosive passage through the vent (Fisher, 1963).

The plagioclase feldspar tends toward the calcic end of the andesine-labradorite interface and occurs as euhedral, tabular to lathlike crystals commonly showing normal zoning and albite twinning. Plagioclase crystals also contain magnetite and plagioclase inclusions.

The latest eruptions of May 25 and June 12 were distributed northwest and southwest of the vent respectively. The tephra does not demonstrate any marked compositional change from the major eruption of May 18, except that plagioclase became more calcic, progressing from lower range to mid-range labradorite, and the percentage of pyroxene decreased.

REFERENCES

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Shulters, M. V.; Clifton, D. G., 1980, Mount St. Helens ash fall in the Bull Run watershed, Oregon, March - April 1980: U.S. Geological Survey, Portland, Open-File Report 80-740, 9 p.

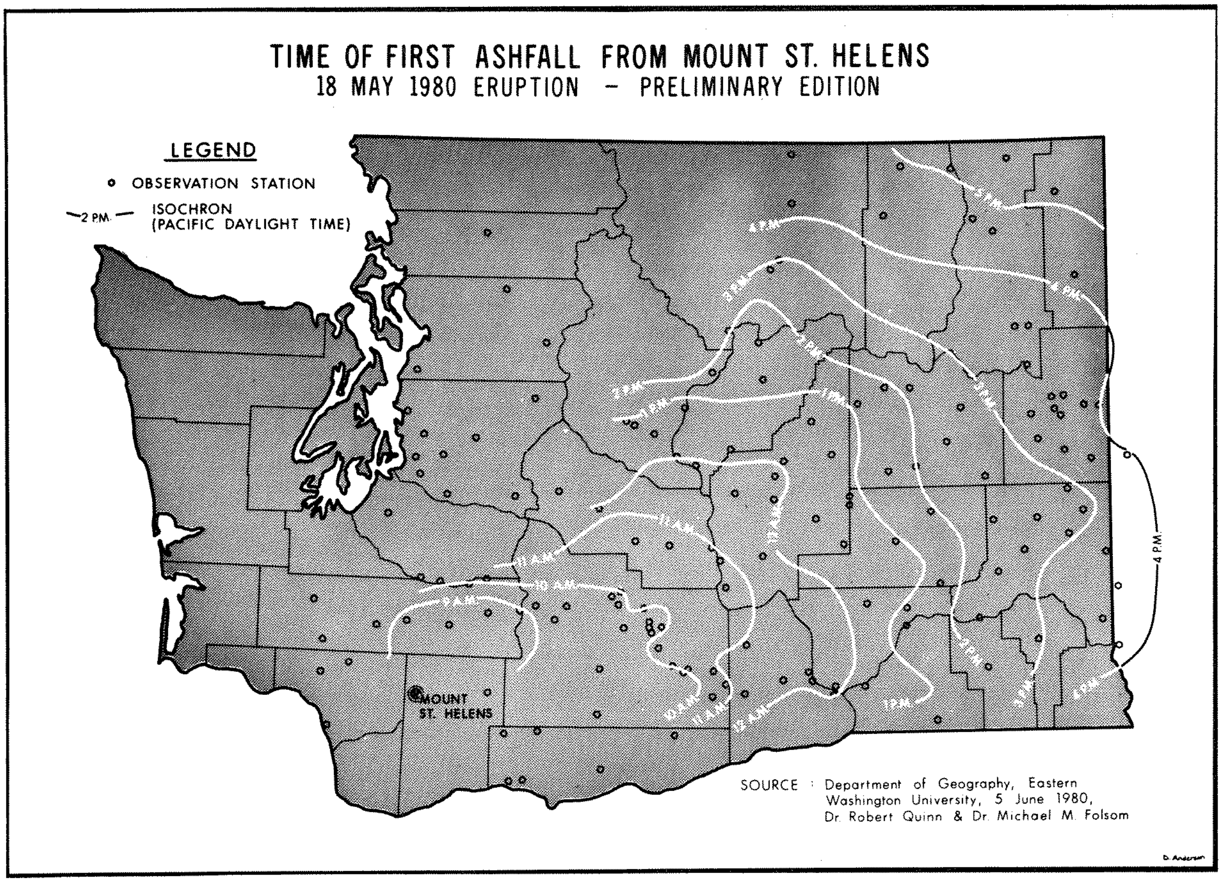
Verhoogan, Jean, 1937, Mount St. Helens, a Recent Cascade volcano: University of California Bulletin of the Department of Geological Sciences, v. 24, no. 9, p. 263-302.

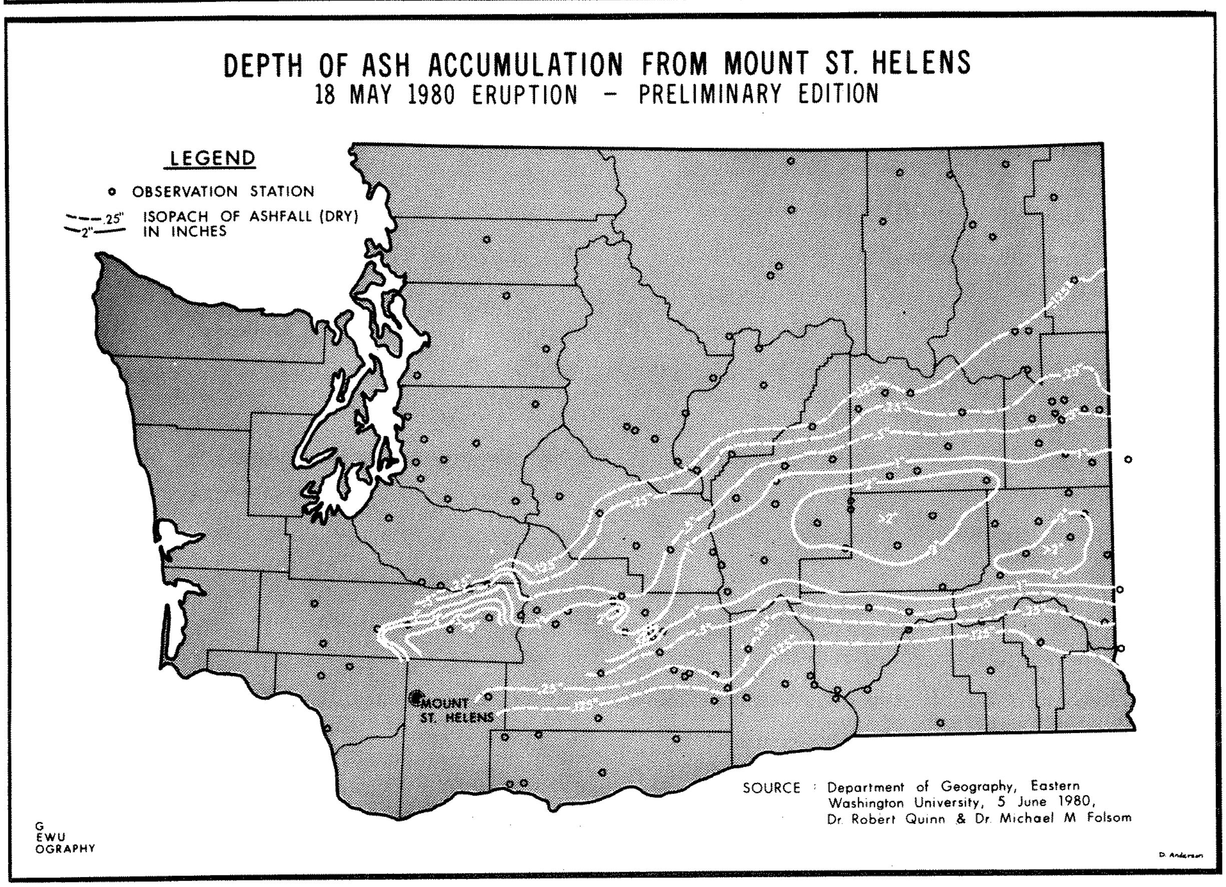
MOUNT ST. HELENS ASH FALL DISTRIBUTION

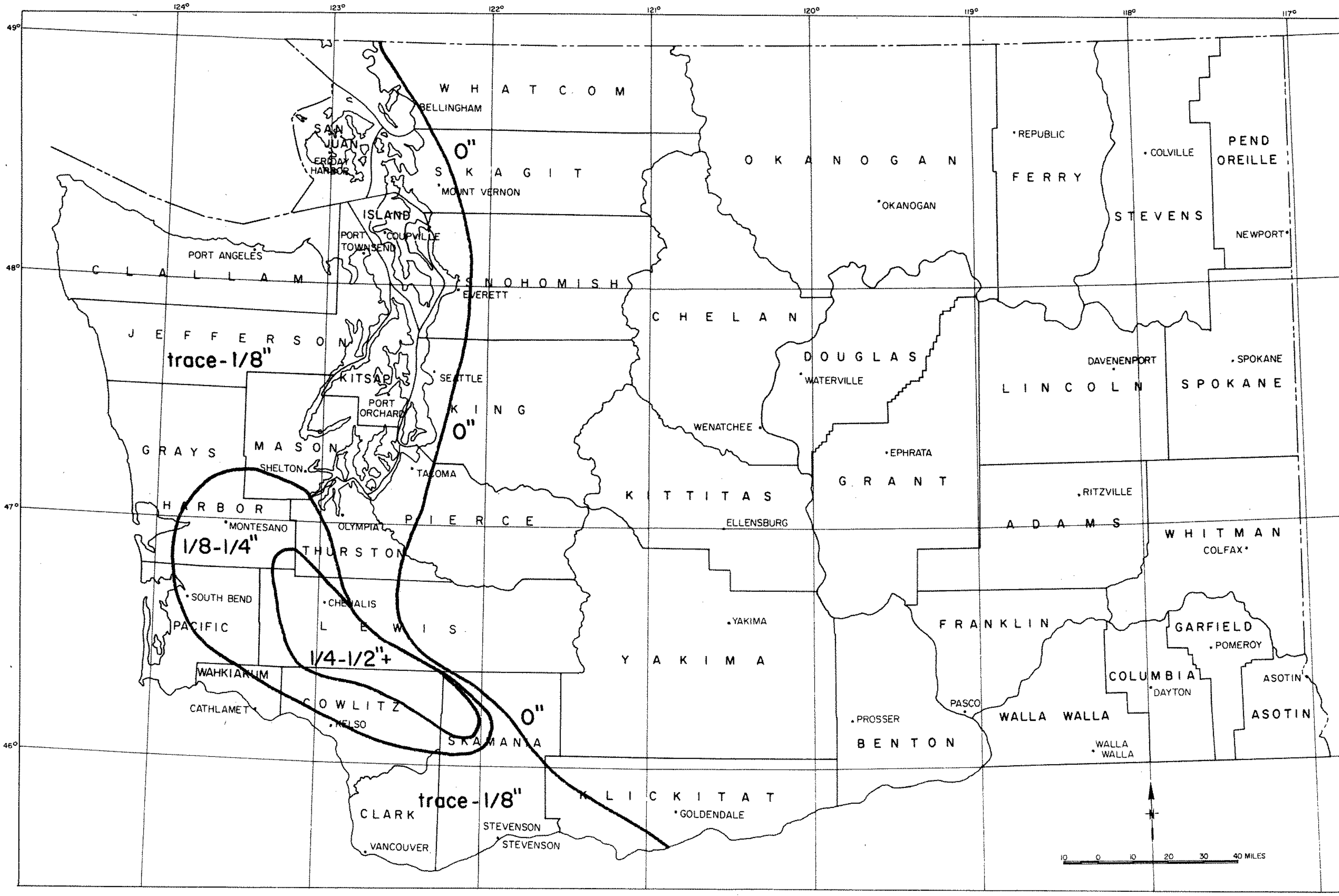
The following maps portray the distribution of ash erupted from Mount St. Helens on May 18 and 25, and June 12, 1980. The two maps for the eruption of May 18, compiled from approximately 100 observation points in Washington and adjacent Idaho, were furnished by Robert R. Quinn and Michael M. Folson of the Department of Geography and Anthropology, Eastern Washington University, Cheney, Washington.

The first map in the pair shows the distribution and depth of ash accumulation from this eruption; the second map shows the time of arrival of this ash at the various observation points.

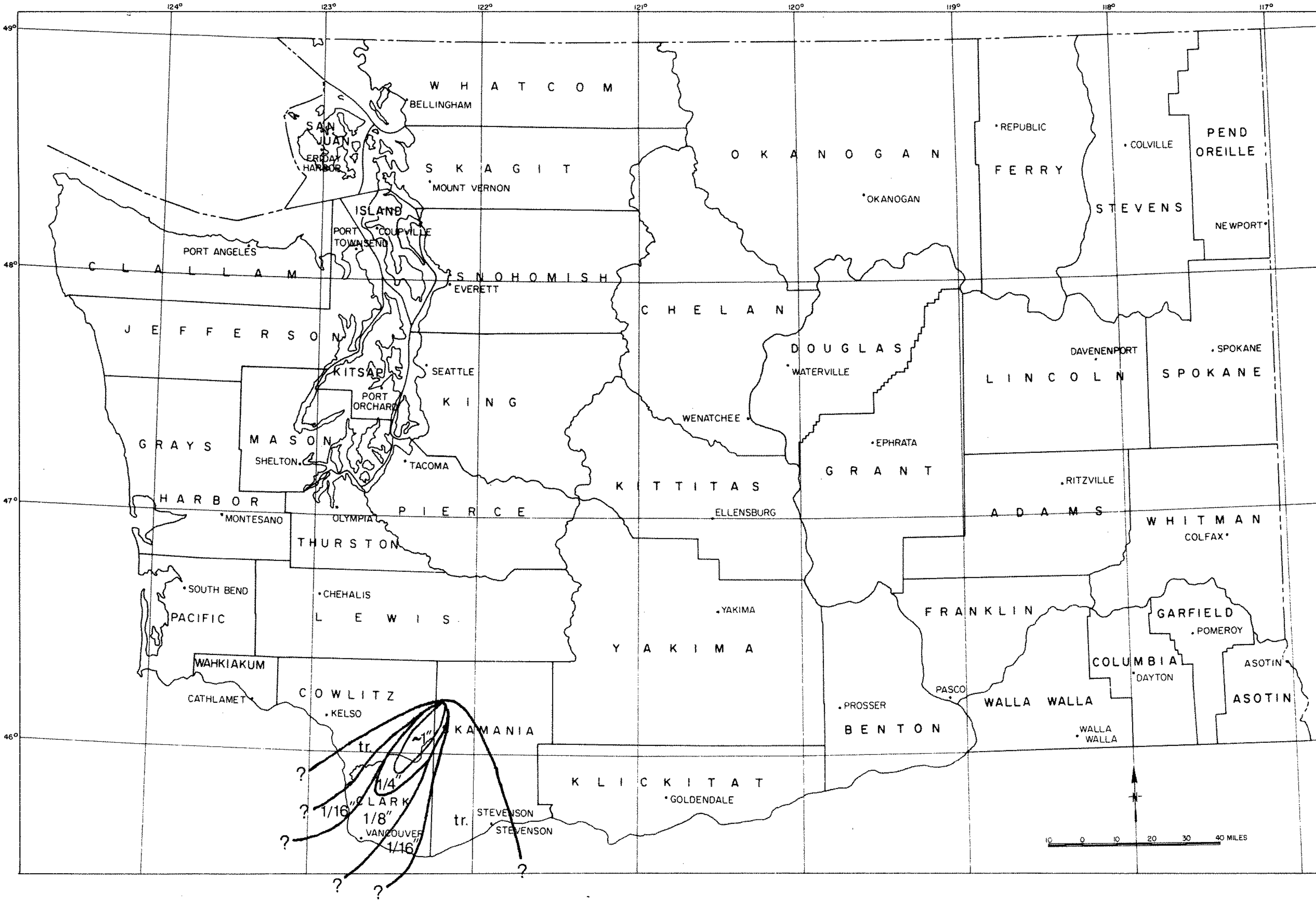
The next two maps, for the eruptions of May 25 and June 12, were compiled by division geologists from data supplied by various county and state agencies, universities, and by numerous individuals. As information for these last two maps was collected from a few hours to a few days after the respective eruptions, they should be regarded as very approximate. Numerous discrepancies were noted in the data as it was being assembled for the maps. This is due, in part, to the fact that the tephra settles and compacts up to approximately one-half of its original thickness after lying on the ground for only a few days. In addition, it is very susceptible to redistribution by subsequent local winds and rain. These facts, along with variations in measurement methods, make it essentially impossible to improve on the quality of these maps.


TIME OF FIRST ASHFALL FROM MOUNT ST. HELENS
18 MAY 1980 ERUPTION - PRELIMINARY EDITION
LEGEND
OBSERVATION STATION
2 PM ISOCHRON (PACIFIC DAYLIGHT TIME)
MOUNT ST. HELENS
9 A.M.
10 A.M.
11 A.M.
12 A.M.
1 P.M.
2 P.M.
3 P.M.
4 P.M.
5 P.M.
SOURCE : Department of Geography, Eastern Washington University, 5 June 1980, Dr. Robert Quinn & Dr. Michael M. Folsom
D. Anderson


DEPTH OF ASH ACCUMULATION FROM MOUNT ST. HELENS
18 MAY 1980 ERUPTION - PRELIMINARY EDITION
LEGEND
OBSERVATION STATION
.25" 2" ISOPACH OF ASHFALL (DRY) IN INCHES
MOUNT ST. HELENS
.125"
.25"
.5"
1"
2"
>2"
SOURCE : Department of Geography, Eastern Washington University, 5 June 1980, Dr. Robert Quinn & Dr. Michael M. Folsom
G EWU OGRAPHY
D. Anderson



Preliminary ash thickness distribution map of May 25, 1980 eruption, Mount St. Helens, by Josh Logan, division geologist
June 5, 1980

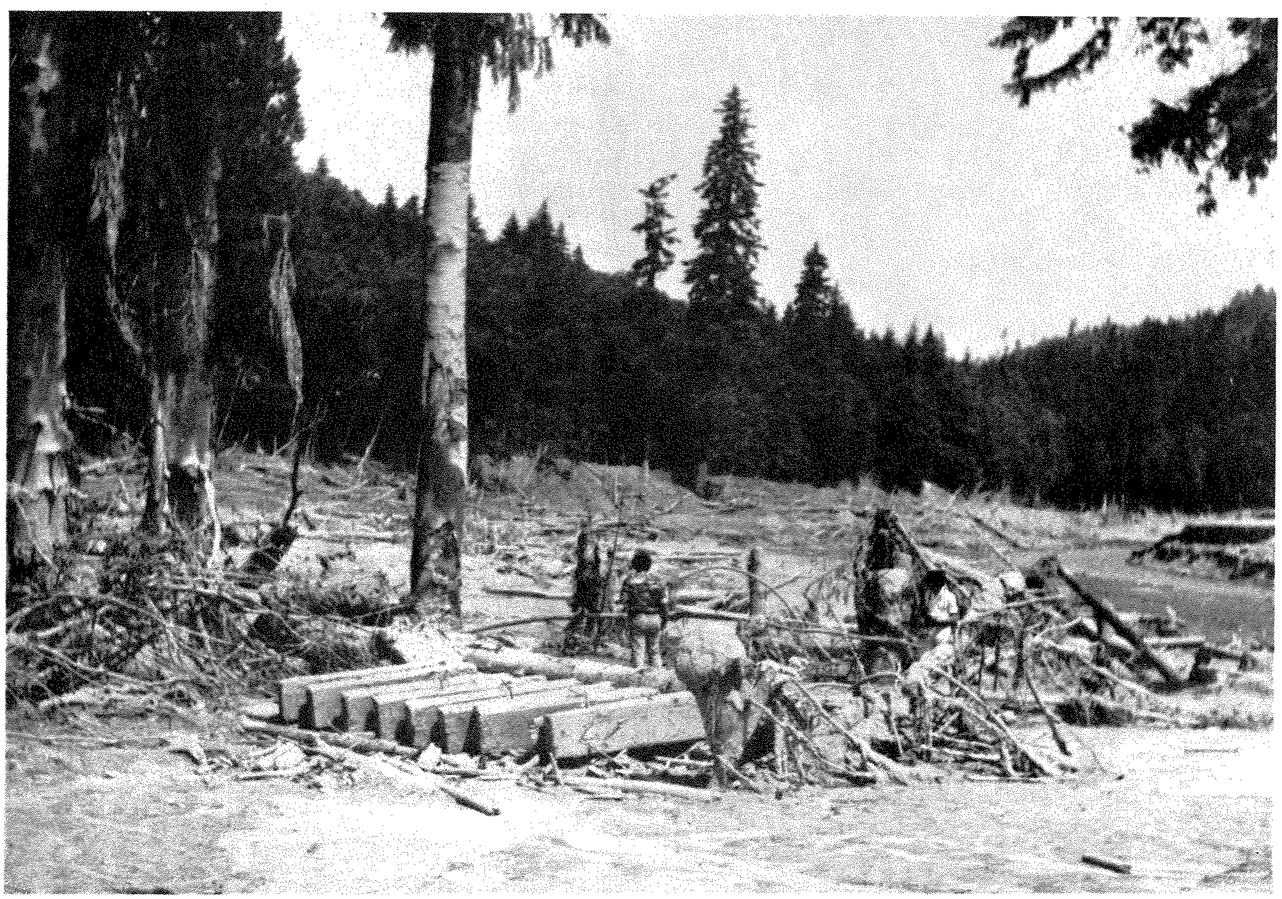


Preliminary ash thickness distribution map of June 12, 1980 eruption, Mount St. Helens, by Josh Logan and James G. Rigby, division geologists, June 20, 1980.

TOUTLE RIVER RECEIVES EXTENSIVE DAMAGE

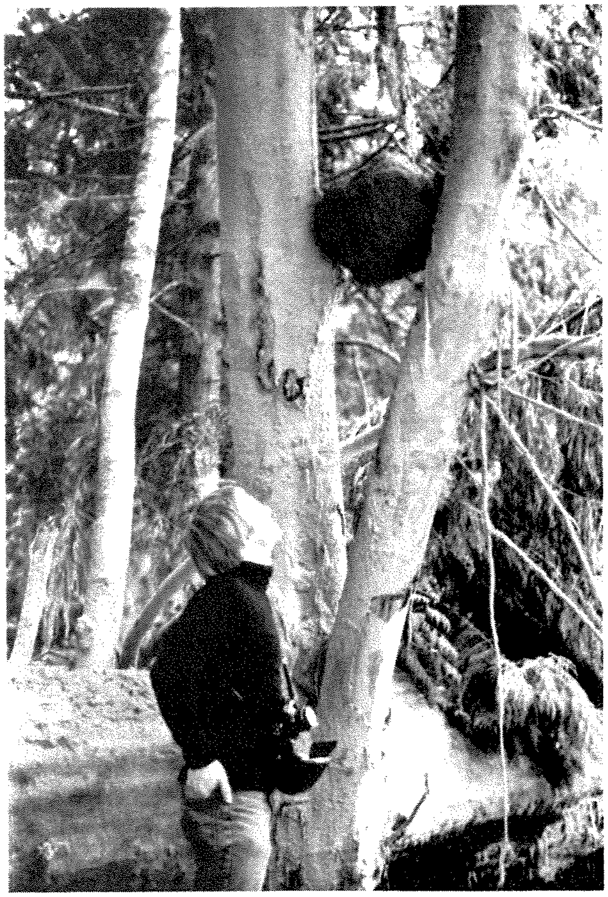
U.S. Geological Survey reports extensive changes in the hydrologic conditions of the Toutle and lower Cowlitz Rivers as a result of the May 18, 1980 eruption of Mount St. Helens. The channels of both rivers in the affected areas are clogged with mud debris. The USGS estimates that the mudflow from the eruption left more than 2.42 billion cubic yards of material remaining in the Toutle River valley, 40 million cubic yards in the Cowlitz River valley, and 16 million cubic yards in the Columbia River channel.

The USGS estimates that some 140,000 acre-feet of water was released from the melting of snow and ice on the mountain. This runoff caused unprecedented flooding in the Toutle and lower Cowlitz valleys. On May 18, 1980, the day of the eruption, a flood occurred in the South Fork of the Toutle that had a peak flow of 47,000 cubic feet per second at the stream flow gage at Silverlake. A few hours later, a silt-laden flood came down the North Fork that destroyed the Silverlake stream gage. High water marks at the site, together with information recovered at the Castle Rock gaging station on the Cowlitz River, indicate that the flood from the North Fork reached a stage of more than 53 feet. This exceeded the previous maximum stage of a few hours earlier by 30 feet and had a discharge of 150,000 cubic feet per second. The average flow is 1,986 cubic feet per second and previous maximum was 37,600



Notice high-water mark on tree near Coal Bank Bridge at Toutle.

cubic feet per second in 1910. The torrent dumped such a large volume of silt and clay in the Cowlitz River that it has seriously reduced the channel's flow capacity. The silt and debris deposited in the Columbia River at Longview built a shoal and filled the shipping channel. Depth of the water was reported at 15 feet where it normally is about 45 feet.



Boulder lodged in tree along south bank of North Fork of the Toutle River, about 2 miles east of intersection of state highway 505.

Flood damage on the Toutle River was extensive, six bridges were washed out, and about 25 miles of highway were destroyed. Disaster Relief estimates that 61 homes were totally destroyed, 55 homes have major damage, and 64 homes were rendered inaccessible (50 percent of these are expected to have major or total damage).

The waters or slurry went over the banks of the Cowlitz at Castle Rock and flooded the Cowlitz County fairgrounds and two subdivisions. It appears from preliminary data that the bottom of the Cowlitz River bed was raised some 15 to 20 feet, which presents a considerable flood threat from any high water that might occur. To relieve this situation, the U.S. Army Corps of Engineers plans to dredge out the Cowlitz River channel up river to the mouth of the Toutle.

For water data on the Mount St. Helens eruption contact:

Charles R. Collier
District Chief
U.S. Geological Survey
1201 Pacific Avenue - Suite 600
Tacoma, WA 98402
Telephone: (206) 593-6510

AGENCIES INVOLVED IN STUDIES OF MOUNT ST. HELENS

We are including in our newsletter a partial list of agencies involved in studies of Mount St. Helens. Any changes, corrections, or additions should be submitted to the Washington Division of Geology and Earth Resources.

1. University of Washington, Department of Atmospheric Sciences, Seattle, WA 98195
   Contact: Dr. Larry Radke
   Phone: (206) 543-6225
   Activity: Air pollution studies (looking at 24 major gas species from St. Helens, especially sulfur gases, Freons, NO_2, ammonia, and hydrocarbons.

2. University of Washington, Department of Geophysics, Seattle, WA 98195
Contact: Dr. Steve Malone
Phone: (206) 543-8020
Activity: Seismic monitoring and modeling.

3. University of Washington, Department of Geological Sciences, Seattle, WA 98195
Contact: Drs. John Adams, Tom Dunn, Tony Irving, or Steve Porter.
Phone: (206) 543-1190
Activity: Morphology of flow deposits (Dunn); petrology of ash and other eruptive materials (Irving); spectral studies of tephra (Adams); and volcanology of eruptions (Porter).

4. University of Washington, Quaternary Research Center, Seattle, WA 98195
Contact: Dr. Estella Leopold, Director
Phone: (206) 543-1166
Activity: Ecological studies, some in conjunction with other institutions: (a) Forest ecosystems—impact of new ash on present ecosystems in forests (with College of Forestry); (b) terrestrial ecosystems—studies of plant succession in denuded areas, etc.; (c) Columbia Basin steppe studies—effects of new ash on sage communities in the Basin (with Washington State University); (d) wildlife studies—effects of eruption on small mammals (with Department of Zoology).

5. Washington State University, Air Pollution Laboratory, Pullman, WA 99163
Contact: E. Robertson
Phone: (509) 335-1526
Activity: Studying possible ozone perturbations using Dr. Radke's data.

6. Washington State University, Department of Geology, Pullman, WA 99163
Contact: Drs. Hooper, Sorem, Rosenberg, and Kittrick
Phone: (509) 335-3009
Activity: X-ray fluorescence and optical studies of tephra (Hooper); X-ray diffraction (Sorem), with C. Knowles, University of Idaho; and surface energy of glass (Rosenberg and Kittrick).

7. Eastern Washington University, Department of Geography, Cheney, WA 99004
Contact: Dr. Robert Quinn
Phone: (509) 235-7050
Activity: Ash distribution mapping and meteorological aspects of ash fall.

8. Central Washington University, Department of Geography, Ellensburg, WA 98926
Contact: Dr. John Ressler
Phone: (509) 963-1188
Activity: (a) Impact and response study (impact on agriculture, transportation, public health, utilities, and communication), in conjunction with Clark University, Worcester, Mass.; University of Montana, Missoula, Mont.; Eastern Washington University, Cheney, Wash.; and Natural Hazards, Research and Applications Center, Boulder, Colo.; and (b) detailed ash fall mapping and meteorological aspects of ash fall, etc.

9. University of Puget Sound, Department of Geology, Tacoma, WA 98416
Contact: Dr. Norman Anderson
Phone: (206) 756-3129
Activity: (a) Ash distribution; (b) monitored gravity from east dome to near Camp Baker prior to May 18 eruption—plan to reoccupy gravity stations and continue monitoring; and (c) plan to perform petrographic analysis of ash.

10. Western Washington University, Department of Geology, Bellingham, WA 98225
Contact: Dr. Dave Pevear or Dr. Don Easterbrook
Phone: (206) 676-3581
Activity: Clay mineralogy and grain size of tephra, general mineralogy, major elemental analysis, scanning electron microscopy (Pevear); and temperature of emplacement of lahars (Easterbrook).

11. Washington State Department of Social and Health Services, Environmental Lab Section, 1409 Smith Tower Bldg., M.S. B-17-9, Seattle, WA 98104
    Contact: Bob Mooney
    Phone: (206) 464-5371
    Activity: Conducted some analyses for radioactivity in emissions, including radon; also doing chemical analyses of ash.

12. Department of Natural Resources, Division of Geology and Earth Resources, Olympia, WA 98504
    Contact: Don Ford or Eric Schuster
    Phone: (206) 753-6183
    Activity: Ash distribution and sampling, geologic hazards assessment and mapping, aerial photography, photographic collection, continued geothermal studies of thermal springs (heat flow measurements, geochemistry of thermal springs, etc.), and coordination of state-wide studies.

13. Oregon Graduate Center, Beaverton, OR 97005
    Contact: Dr. Reinhold Rasmussen
    Phone: (503) 645-1121
    Activity: Studying rare gases as fluorocarbons, CO_2, methane, and some sulfur gases.

14. Oregon State University, Department of Geography, Corvallis, OR 97331
    Contact: Dr. Charles Rosenfeld
    Phone: (503) 754-3141
    Activity: Continuing radon and infrared surveillance, monitoring crater area with thermal infrared instrumentation, looking at infiltration of water from several peripheral lakes, and monitoring ground-water flow.

15. Oregon State University, Department of Geology, Corvallis, OR 97331
    Contact: Dr. Ed Taylor
    Phone: (503) 754-2484
    Activity: Chemical and mineralogic studies of ash.

16. Portland State University, Department of Earth Sciences, Portland, OR 97207
    Contact: Drs. John Allen, Len Palmer, or Paul Hammond.
    Phone: (503) 229-3022
    Activity: Tephra collection, photographic collection of evolution of 1980 eruptive history; "Mount St. Helens Box Score"—A monthly listing of notable eruptions and earthquakes, etc.; and the St. Helens Research and Coordinating Committee (for access and coordination of research activities).

17. Foundation Sciences, Inc., 1630 SW. Morrison, Portland, OR 97205
    Contact: Rick Kienle, Bill Sidle
    Phone: (503) 224-4435
    Activity: Study of airfall hazards (mainly within 30 miles of Mount St. Helens). The study includes the following: tephra thickness, sorting, abrasion, leachate, gradation, and compaction (wet and dry densities). Comparison of tephra of 18th to St. Helens Y and W ash (sampled and mapped), and volcanic hazards as applied to Trojan Nuclear Plant.

18. Oregon Museum of Science and Industry (OMSI), 4015 SW. Canyon Rd., Portland, OR 97221
    Contact: Clara Fairfield
    Phone: (503) 229-5580
    Activity: Collecting data on changes in barometric pressure associated with eruptions of Mount St. Helens; ash fall distribution.

19. University of Idaho, Department of Plant and Soil Sciences, Moscow, ID 83843
    Contact: Dr. Ula Moody
    Phone: (208) 885-7012
    Activity: Impact of ash on soils and fertility (soluble and exchangeable ions); particle size distribution and petrography.

20. University of Idaho, Department of Geology, Moscow, ID 83843
Contact: Dr. Charles Knowles
Phone: (208) 885-6192
Activity: Electron microprobe analysis of tephra.

21. U.S. Geological Survey, 301 E. McLaughlin, Vancouver, WA 98663
Contact: Dr. Robert Christiansen (Scientific Studies); Drs. Dwight Crandall or Donal Mullineaux (Geologic Hazard Studies)
Phone: (206) 696-7693, 94, 95
Activity: Have looked at CO, COS, SO_2, H_2S, and other gases in emissions and dissolved in water in crater floor. (USGS is also doing work on seismicity, structures, deformation, mapping, geologic hazards, etc.)

22. U.S. Geological Survey, University District Bldg. 1107 NE. 45th, Suite 125, Seattle, WA 98105
Contact: Dr. Dave Frank
Phone: (206) 442-7300
Activity: Thermal IR work.

23. U.S. Geological Survey, Water Resources Branch, 1201 Pacific Ave., Suite 600, Tacoma, WA 98402
Contact: Chuck Swift or John Cummings
Phone: (206) 593-6510
Activity: Studies related to ground water and hydrology include the following: (a) storage and discharge determinations along affected drainages; (b) sediment sampling; and (c) precipitation effects (in cooperation with U.S. Weather Bureau).

24. U.S. Army Corps of Engineers, P. O. Box 2946, Portland, OR 97208
Contact: Pat Keough
Phone: (503) 221-6056
Activity: Construction of sediment traps on Toutle River; air photos, and floodplain maps (post-eruption).

25. Dartmouth College, Department of Earth Sciences, Hanover, NH 03755
Contact: Richard Stoiber, Stanley Williams, and Lawrence Malinconico
Phone: (603) 646-1110
Activity: Analysis of gaseous emissions, including SO_2 and soluble ash leachates (Cl^-, SO_4^{2-}, F^-).

MAPS AND AIR PHOTOS OF MOUNT ST. HELENS AND SURROUNDING AREA

Available from: Washington State Department of Transportation, 1655 S. Second Ave., Tumwater, WA 98504. Contact: Jim Walker. Phone (206) 753-2162.

Paper Print Positives

Date flown	Scale	Type	Areas
May 19, 1980	1 inch=500 ft.	Black and white; vertical	Toutle River
May 31, 1980	1 inch=1,000 ft.	True color; vertical and oblique	E-W and N-S passes over crater area
June 25, 1980	1 inch=1,000 ft	True color; oblique and vertical	Toutle River from I-5 to Spirit Lake
June 26, 1980	1 inch=1,000 ft.	True color; oblique and vertical	Toutle River from I-5 to Spirit Lake
June 27, 1980	1 inch=1,000 ft.	True color; vertical	Spirit Lake and Coldwater Canyon

(Also have some low-level coverage, 1 inch=200 ft., of various areas in true color and black and white.)

Available from: Washington State Department of Natural Resources, Resource Inventory Section-Photo Sales, Public Lands Bldg., Olympia, WA 98504. Phone: (206) 753-5338.

Paper Print Positives

Flight and date	Scale	Type	Area
MSH-C-80 June 19, 1980	1:24,000	Color; vertical	Complete coverage of T. 6-12 N., R. 3-5 E.; partial coverage of T. 6-12 N., R. 6 E., and T. 7-12 N., R. 2 E. Remaining areas of T. 6-12 N., R. 1-7 E. to be flown during improved weather
SWP-C-80 April 29 and May 17, 1980	1:12,000	Color; vertical	Partial coverage west of Mount St. Helens; remaining areas in T. 7-11 N., R. 3-6 E. to be flown during improved weather

(Also have some orthophoto maps available.)

Available from: Washington State Department of Natural Resources, Bureau of Surveys and Maps, 524 S. Jefferson, Olympia, WA 98504. Phone (206) 753-5337.

1. Mount St. Helens special edition base map by U.S. Geological Survey; scale 1:100,000, topographic, color printed; $3 each (also for sale by the U.S. Geological Survey, Denver, CO 80225, or Reston, VA 22092).
2. Mount St. Helens Spirit Lake topographic and recreation map by U.S. Forest Service, 1 inch=1 mile, 50 cents.
3. Gifford Pinchot National Forest recreation map, by U.S. Forest Service; 1 inch=2 miles, 50 cents (this map and the one above are also available from the U.S. Forest Service, Gifford Pinchot National Forest, 500 W. 12th St., Vancouver, WA 98660).
4. All U.S. Geological Survey 7½- and 15-minute topographic quadrangle maps of Washington.

Available from: U.S. Army Corps of Engineers, Portland District, P. O. Box 2946, Portland, OR 97208. Contact: Jim Francis, Photogrammetry Section. Phone (503) 221-6475.

Black and white vertical airphotos, scale 1:3,600, taken on May 22, 1980, of Cowlitz River from mouth to Packwood. (Also have maps of floodplains [post-eruption].)

Available from: U.S. Department of Interior, Geological Survey, EROS Data Center, Sioux Falls, SD 57198. Phone (605) 594-6511.

Color IR vertical (and some oblique) high-altitude U-2 photography at scales of 1:32,500 and 1:130,000, from May 20, 1980 flights over Mount St. Helens (approximately 90 percent cloud cover), and June 19, 1980 flights (cloud-free). Pre-eruption coverage also available.

Available from: Cowlitz County Court House, Assessors Office, 4th and Academy, Kelso, WA 98626. Phone (206) 577-3010.

County plat maps, scale 1 inch=200 or 400 ft., available to government agencies at $2 each on paper; available to public at 50 cent each on microfisch, or can be viewed in Assessors Office.

U.S. GEOLOGICAL SURVEY
OUTLINE OF PERSONNEL AND PROJECTS

Vancouver, Washington

June 20, 1980

All personnel are on temporary assignments, some rotate regularly and some come as needed or available.

Scientist in charge
D. W. Peterson (B)[1/]

Coordinator of monitoring, observations, and field studies:
R. L. Christiansen (B), D. W. Peterson, and R. W. Decker (C)

Analysis of hazards, interface with Federal, State, and local agencies, public utilities, etc:
D. R. Crandall (A), D. R. Mullineaux (A), and C. D. Miller (A)

1/ U.S. Geological Survey office locations.

A. U.S. Geological Survey, Box 25046, Federal Center, Denver, CO 80225

B. U.S. Geological Survey, 345 Middlefield Road, Menlo Park, CA 94025

C. Hawaii Volcano Observatory, Hawaii National Park, Hawaii 96718

D. U.S. Geological Survey, National Center, 12201 Sunrise Valley Dr., Reston, VA 22092

E. U.S. Geological Survey, 601 East Cedar Avenue, Flagstaff, AZ 86001

F. U.S. Geological Survey, 1107 NE. 45th Street, Seattle, WA 98105

Tilt measurements and analysis, liaison with seismic net, magnetometer, microbarograph:
A. T. Okamura (C), J. Dvork (B)

Deformation studies, miscellaneous volcano observations:
D. A. Swanson (B), P. W. Lipman (A), J. G. Moore (B)

Gas studies, geochemistry:
T. J. Casadevall (C), M. Sato (D), K. M. McGee (D), W. Rose, Jr. (Michigan Tech.), A. Anderson (Univ. of Chicago), D. M. Harris (D)

Thermal infrared and other thermal emission studies:
H. Kieffer (E), D. G. Frank (F), J. D. Friedman (A)

Gravity:
R. Jachens, (B), D. Dzurisin (C), A. Eggers (Univ. of Puget Sound), R. Spydell (A)

Photogeology, image interpretation, liaison with side-looking radar:
H. Kieffer (E), D. G. Frank (F)

TV surveillance system (planned with Sandia)
R. P. Hoblitt (A), C. D. Miller (A)

Ash and ejecta stratigraphy and lithology:
A. M. Sarna-Wojcicki (B), R. B. Waitt, Jr. (B), D. Dzurisin (C), N. G. Banks (C), G. A. Izett (A), R. E. Wilcox (A)

Debris flow study:
B. Voight (Penn State), R. J. Janda (B), H. Glicken (B)

Stability of debris-flow fill in North Fork Toutle Valley:
T. L. Youd (B), R. C. Wilson (B)

Engineering implications of the Mount St. Helens eruptions:
R. L. Schuster (A)

Pyroclastic flow studies:
R. W. Rowley (A), Mel Kuntz (A)

Mudflow studies:
R. J. Janda (B), K. M. Nolan (B)

Blast-deposit study:
R. P. Hoblitt (A), C. D. Miller (A), S. W. Kieffer (E)

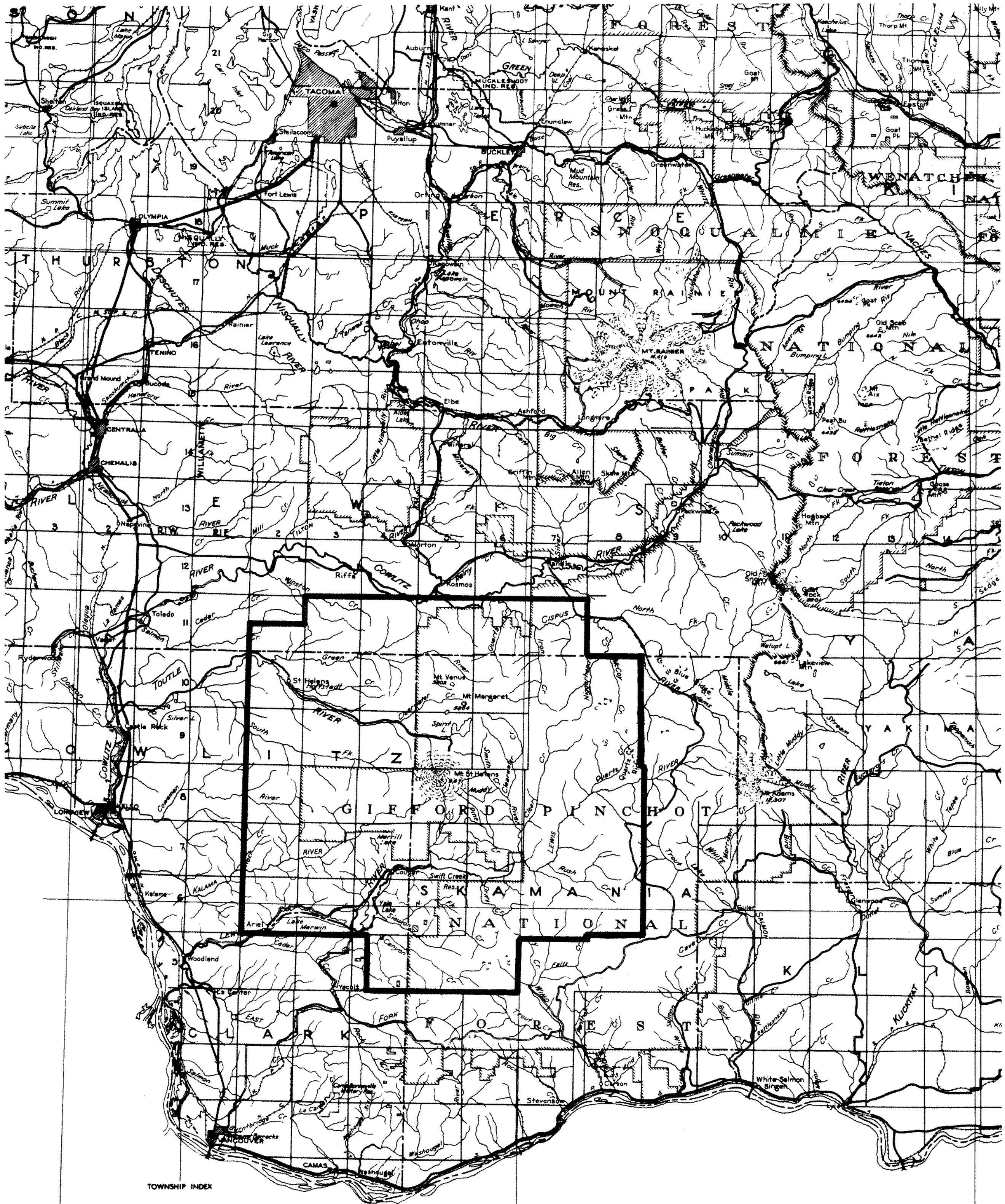
Temperature measurements on deposits:
R. P. Hoblitt (A), N. G. Banks (C)

Hydrothermal alteration and weathering:
D. Dethier (F), D. G. Frank (F), D. Pevear (F)

Eruption dynamics
S. W. Kieffer (E)

Electromagnetic soundings:
J. N. Towle (A)

Eyewitness accounts:
J. G. Rosenbaum (A), J. W. Vallance (A), R. Decker (C)



Red zone area as of June 3, 1980.

ST. HELENS COORDINATING COMMITTEE FORMED

The rapidly increasing number of requests by scientific and educational groups to inspect Mount St. Helens has prompted the U.S. Geological Survey staff at Vancouver to ask two Portland geologists to form a coordinating committee to screen all applicants.

The committee is headed jointly by Dr. John E. Allen, Professor Emeritus of Geology, Portland State University, and Ralph S. Mason, former state geologist with the State of Oregon Department of Geology and Mineral Industries. Advisory members include representatives from Portland State University, University of Oregon, Oregon State University, University of Washington, the Washington Division of Geology and Earth Resources, and the Oregon Department of Geology and Mineral Industries.

"The Mount St. Helens eruption is by any standard the largest and most destructive volcanic disaster experienced in the conterminous United States since the coming of the white man," Dr. Allen asserted. "The mountain has become overnight a laboratory in which not only the active volcanic processes and their effects can be studied, but also destruction of plant, animal, and fish life by a unique catastrophic event can be observed," he added.

All applicants wishing to explore the volcanic activity of the mountain within the red zone or the environmental and ecological impacts resulting from the eruption should request a ground access permit from the committee at least 10 days prior to their planned trip. If approved, the applicant will receive a permit which will be honored at the various roadblocks surrounding the hazardous area.

Inquiries should be addressed to the St. Helens Coordinating Committee (SHCC), Earth Sciences, Portland State University, P. O. Box 751, Portland, OR 97207, telephone (503) 229-3022 or 223-6375. The committee is a non-profit organization staffed by volunteers. A $10 processing fee is charged to defray expenses.

A permit is also required for entry into the red zone from the Department of Emergency Services. The permits can be obtained from the Driver License Examining office in Vancouver, Longview, Morton, and Centralia.

DIVISION PUBLISHES NEW REPORTS

The following recently published reports are now available from the Division of Geology and Earth Resources, Olympia:

Information Circular 69

Directory of Washington mining operations, 1979, by Carl R. McFarland, Glennda B. McLucas, James R. Rigby, and Keith L. Stoffel. 1980. 3 figs. 100 p. Free.

Information Circular 70

Theses on Washington geology—A comprehensive bibliography, 1901-1979, compiled by Connie Manson. 1980. 216 p. 2 plates. Price $5.50. [In press and will not be available for distribution until the end of July.]

Information Circular 71

The 1980 eruption of Mount St. Helens, Washington; Part 1: March 20-May 19, 1980, by Michael A. Korosec, James G. Rigby, and Keith L. Stoffel. 1980. 4 figs. 27 p. Free.

Bulletin 72

Washington coastal geology between the Hoh and Quillayute Rivers, by Weldon W. Rau. 1980. 74 figs. 57 p. Price $5.00.

RECENT U.S. GEOLOGICAL SURVEY OPEN-FILE REPORTS ADDED TO OUR LIBRARY

The following reports are now available for inspection in our division library:

Preliminary geologic map of the Clear Lake SE. quadrangle, Skagit County, Washington, by David P. Dethier, John T. Whetten, and Paul R. Carroll. USGS Open-File Report 80-303, 2 plates, scale 1:24,000.

Probabilistic estimates of maximum seismic horizontal ground motion on rock in the Pacific Northwest and the adjacent Outer Continental Shelf, by David M. Perkins, Paul C. Thenhas, Stanley L. Hanson, Joseph I. Ziony, and S. T. Algermissen. USGS Open-File Report 80-471, 7 plates, scale 1:2,500,000, 39 p.

Evaluation of the Wilkeson-Carbonado coal field, Pierce County, Washington for hydraulic coal mining (In two parts): Part One—Geology, by Harold H. Arndt and Bion H. Kent, 40 figs., 1 plate, scale 1:24,000, 109 p.; Part Two—Water resources, by F. A. Packard and W. L. Haushild, 6 figs., 3 tables, 19 p. USGS Open-File Report 80-802.

GEOLOGIC MAP WINS HONORABLE MENTION

A geologic map and report recently published by the Division of Geology and Earth Resources entitled "Geologic map in the vicinity of the lower Bogachiel and Hoh River valleys, and the Washington coast" was awarded an honorable mention in a national contest sponsored by the American Congress on Surveying and Mapping. Of 90 professional entries, 5 blue ribbons and 15 honorable mentions were presented. Weldon Rau authored and designed the publication; it was edited by Laura Bray, and the cartographic work was done by Gibb Johnson.

GEOLOGIC MAP OF SOUTHERN CASCADE RANGE NOW AVAILABLE FOR PURCHASE

A geologic map of the southern Cascade Range of Washington can be purchased for $18 from Portland State University, P. O. Box 751, Portland, Oregon, 97207. It can also be seen in the Division of Geology and Earth Resources library and used for reference.

Reconnaissance geologic map of southern Washington Cascade Range, by Paul L. Hammond. 1980. 2 sheets, scale 1:125,000.

GEOLOGIC RESEARCH PROJECTS BY COLLEGES AND UNIVERSITIES IN WASHINGTON STATE

Listed below is an additional research project to supplement the main listing in our April Geologic Newsletter:

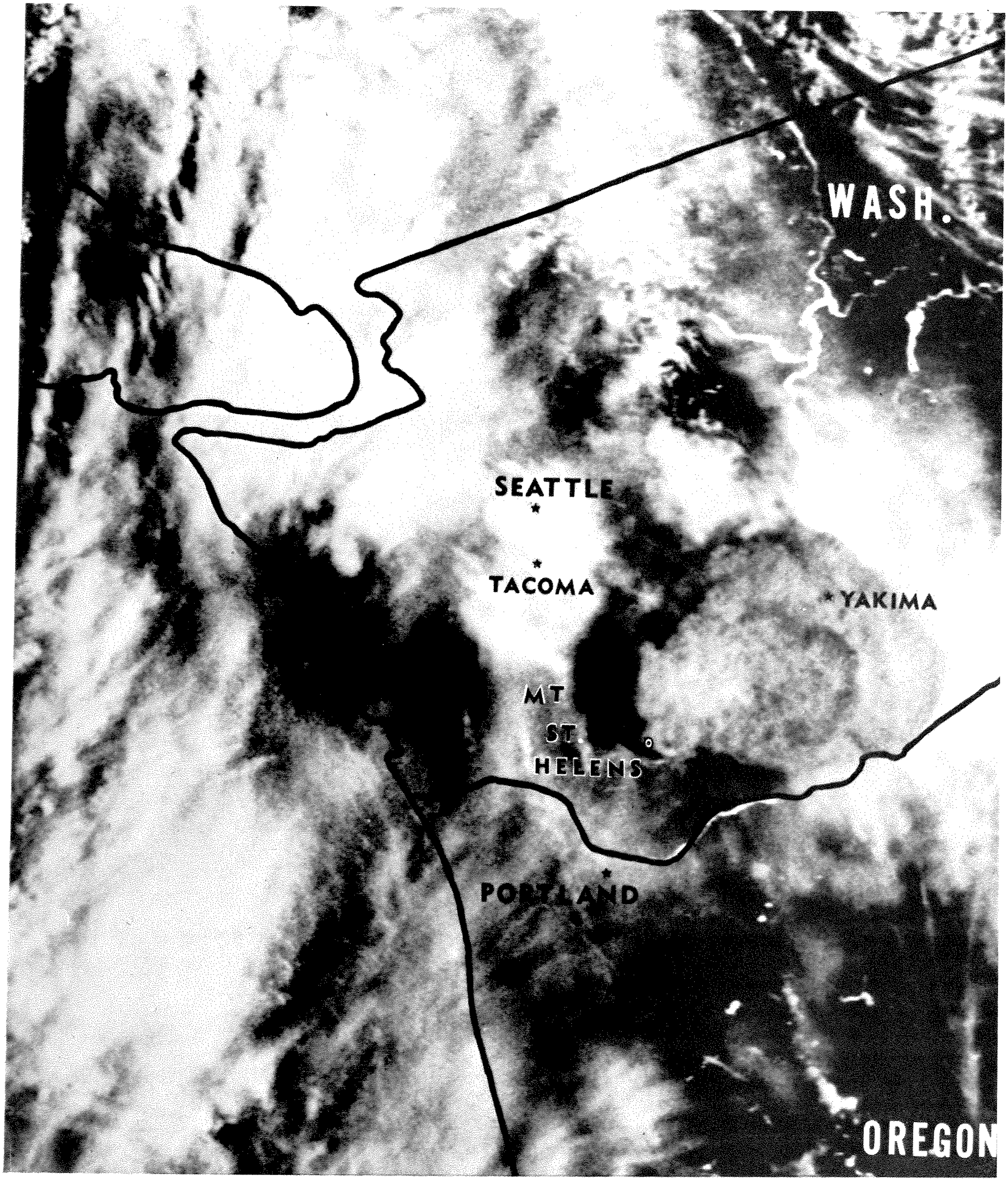
Pacific Lutheran University

- Master's thesis in progress -

Petrology and structural geology of the Indian Creek gneiss (Bob Conley).

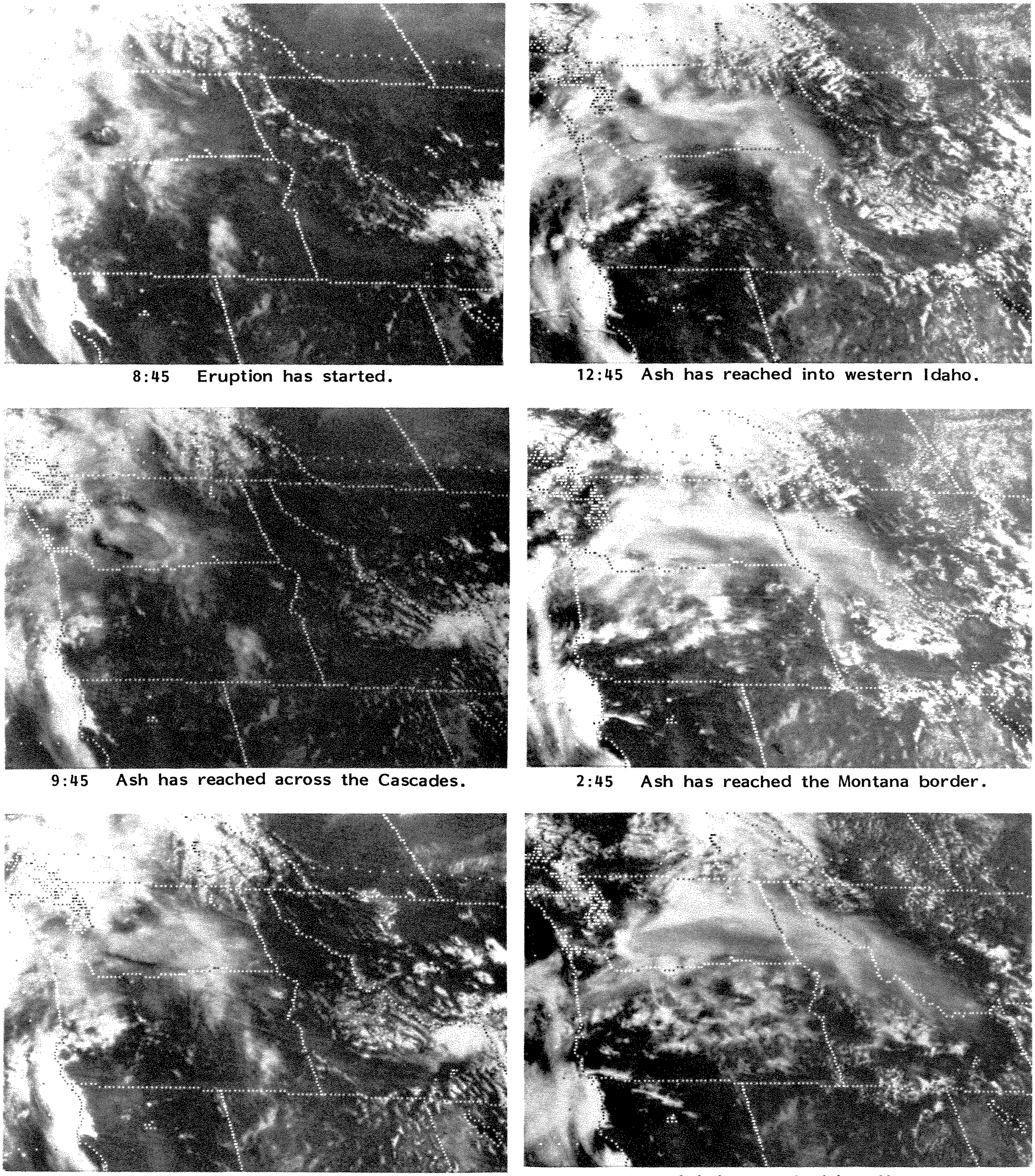
"GOLD AND FISH" PAMPHLET AVAILABLE

The potential impact on fish and wildlife resources of gold prospecting in Washington's streams has prompted the adoption of new, simplified gold prospecting regulations by the state Departments of Game and Fisheries. A 20-page pamphlet, "Gold and Fish," recently released, includes an explanation of the simplified state regulations and federal laws, a stream classification system that identifies streams and specifies mining activities for each type of stream in order to have minimum impact on the fish resource, and an explanation of how the regulations serve to protect fish and wildlife. The pamphlet is available from the Game and Fisheries main and field offices, U.S. Forest Service offices, hunting and fishing license dealers, and the Department of Ecology.



Mount St. Helens eruption of May 18, 1980. NOAA satellite photo taken at 9:54 a.m., one hour and 22 minutes after eruption started at 8:32 a.m. Notice ash plume is now beyond Yakima.

NOAA SATELLITE PHOTOS TAKEN ON MAY 18, 1980 (eruption started at 8:32 a.m.)



8:45 Eruption has started.

12:45 Ash has reached into western Idaho.

9:45 Ash has reached across the Cascades.

2:45 Ash has reached the Montana border.

10:45 Ash has reached the Columbia Basin.

4:45 Ash has reached into Montana.

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